~~Oroville Facilities Relicensing~~
~~Environmental Work Group~~
~~Draft Study Plan~~

~~SPW2.~~ SP-W2 Contaminant Accumulation in Fish, Sediments, and the Aquatic Food Chain

~~Introduction~~

~~December 11, 2001~~January 22February 8February ~~14~~26, 2002

1.0 Introduction/Background

~~The Environmental Work Group has identified sediment accumulation behind Oroville Dam as a potentially significant issue. Sediments trapped behind the dam are potentially laden with metals and organic contaminants, which may bioaccumulate in the food web. Sediments carried into Lake Oroville initially deposit into the upper tributary arms. Decreasing reservoir levels, periodic discharge surges from upstream hydropower generation, and increased tributary discharges from fall rains rework these deposits and carry them further into the reservoir.~~

The Environmental Work Group has identified contamination of fish and sediment behind Oroville Dam as an issue of concern. Contamination of fish from mercury and other metals and organic contaminants is a significant concern in many areas of California, including the Feather River watershed. Lake Oroville tributaries in the upper Feather River watershed experienced significant gold mining activity during the Gold Rush era, and continue to experience significant recreational gold mining activity. Numerous large mercury mines were developed in the Coast Range to supply mercury as an amalgam for gold extraction in the Feather River and other areas. Mercury lost to the tributaries during gold mining operations is slowly being transported downstream with sediments. Though the Gold Rush era has long since passed, significant quantities of mercury still remain in the streams tributary to and in Lake Oroville.

Potentially occurring anoxic conditions beneath the sediment-water interface at the reservoir bottom create ideal conditions for biologically mediated liberation of methyl mercury by sulfate-reducing bacteria. The redistribution of methyl mercury in the water column during lake mixing in the fall and winter may ~~affect the rate of~~facilitate bioaccumulation into the food web, including plankton, fish, and piscivorous birds and other animals, including humans

In addition, other industrial activities in the upper Feather River watershed have contributed metal and organic contaminants, including polychlorinated biphenyls (PCB~~'~~s), which also have an affinity for sediments and bioaccumulate in the food web. Resuspended sediments and recycled metals and organic contaminants in Lake Oroville can be transported downstream to other project waters, including the Diversion Pool, Thermalito Afterbay and Forebay, Oroville Wildlife Area ponds, and the Feather River, where uptake and bioaccumulation in aquatic organisms can occur.

Sediments trapped behind the dam are potentially laden with metals and organic contaminants, which may bioaccumulate in the food web. Sediments carried into Lake Oroville initially deposit into the upper tributary arms. Decreasing reservoir levels, periodic discharge surges from upstream hydropower generation, and increased tributary discharges from fall rains rework these deposits and carry them further into the reservoir.

2.0 Study Objective

The objectivess of the study are are to evaluate: 1) the levels of metals and organic contaminants in sediments impounded within project waters potential bioaccumulation in aquatic organisms of metals and organic contaminants and potential pathways from contaminated sediments deposited as a result; 2) potential effects of contaminated sediments on the food web in the project area, and 3) effects of project features, operations, and maintenance and to use information collected to develop potential protection, mitigation and enhancement measures. on sediment contamination and bioaccumulation in aquatic organisms.

3.0 Relationship to Relicensing/Need for the Study

Sediments in Feather River tributaries are known to carry metal and organic contaminants. Prior to construction of Oroville Dam, sediments carried by the tributaries and the main stem of the Feather River in the reservoir footprint were transported downstream. Subsequent to completion of the dam, sediments carried by the tributaries settle into the upper arms of Lake Oroville, but are reworked by stream flows as reservoir levels drop throughout the summer and are redeposited further into the reservoir area. Thermal stratification in the reservoir during the summer can affect the rate at whichfacilitate the leaching of metals and organic contaminantsleach from the sediments into the water column, where they become available for uptake by aquatic life or release downstream. In addition, sediment dwelling organisms (e.g., crayfish, insects) ingest the sediments and can absorb contaminants. Contaminants in lower trophic levels are bioaccumulated in higher trophic level organisms, and may reach levels that are deleterious to other organisms (including listed species and humans) that ingest them.
them.
Impoundment of the reservoir created conditions in which sediments possibly laden with contaminants are trapped, and which could then allowcan bioaccumulatione of contaminants in the food web. Water with bioavailable forms of metals and organic contaminants that is released from the reservoir may contribute to bioaccumulation in downstream organisms. Bioaccumulation may not have been significant downstream offrom the dam prior to its construction because the metals and organic contaminants were bound to the sediment particles,and thus not readily available for uptake, and transported out of the system with higher flows.

TheThe California Department of Water Resources (DWR) and State Water Resources Control Board have conducted limited sampling for metals in some fish from the reservoir and Feather River downstream from the dam. Analyses of the few fish from Lake Oroville and the Feather River have detected mercury at concentrations that exceed current U.S. Environmental Protection Agency (EPA) and California Office of Environmental Health Hazard Assessment criteria. These data are not sufficient to determine the magnitude and extent of mercury contamination in fish and other organisms, nor the source. Additional analyses of fish

tissue for mercury and other metals and organic contaminants is necessary to determine project effects and compliance with Basin Plan objectives.

Since recreation, including fishing, is a major beneficial use at project facilities, analysis of fish tissues would provide valuable information for fish consumption advisories. ~~No data are available concerning contaminants in sediments in project water bodies.~~ Sampling of sediments ~~is~~ may be necessary to determine whether contamination of biota (if found) is attributable to contaminant sources located within the reservoir or upstream from the project area and if contamination is local or widespread. ~~Since recreation, including fishing, is a major beneficial use at project facilities, analysis of sediments would provide valuable information for fish consumption advisories. For instance, one~~ Certain ~~of the reservoir arms~~ areas may be less contaminated than ~~the~~ others and not warrant the same restrictions as other reservoir locations for consumption of fish. This could only be determined by analyzing sediment samples, since identification of fish with high contaminant loads in a particular area may be due to their recent migration into the sampling area from other contaminated sites. Knowing the location and extent of sediment contamination can help determine and develop reservoir management practices (licensing conditions) that improve the overall water quality and natural and recreational resources of the reservoir.

In addition, some contaminants are not strong bioaccumulators (e.g., some metals such as copper and arsenic), but may be mobilized and made available to the biota under certain environmental conditions (resuspension of sediment deposits from the arms to the main body, depressed oxygen and pH conditions, etc.) found in the reservoir. Organisms can become re-exposed to contaminants as the lake level drops and deposited sediments are resuspended and transported further into the reservoir. The shallow, relatively warm, organic rich waters of the Forebay and Afterbay ~~are ideal for~~could contribute to the methylation of mercury and dissolution of other metals and organic contaminants. Environmental conditions such as these in project water bodies may promote mobilization of sediment bound contaminants and transport out of the "project area" where they could affect threatened and endangered species.

Sediment contamination information can be used to determine where to focus efforts to reduce sediment loading to improve water quality in the reservoir.

Demonstration of compliance with basin plan objectives is necessary for the SWRCB to issue a water quality certification. Basin plan objectives include provisions against increases in suspended sediment discharges and deposition of material that adversely affect beneficial uses, and toxic substances that produce detrimental effects to humans, plants, animals, and aquatic life. The water quality certification is needed ~~to file with the application~~ for license renewal with the Federal Energy Regulatory Commission. Information derived from this study will be used to demonstrate compliance with water quality standards and other appropriate requirements in the application for water quality certification. Information from the study is also needed to address concerns related to endangered species that feed on potentially contaminated aquatic organisms in the project area.

~~Study Area~~

4.0 Study Area

~~The study area~~The s~~S~~tudy a~~A~~rea is generally within the FERC project boundary, but also includes lands adjacent to the project boundary where piscivorous species may occur. ~~The vulnerability of piscivorous species to bioaccumulated contaminants will be evaluated in the terrestrial studies if fish eaten as prey are found to contain high levels of contaminants. The assessment of piscivorous susceptibility will be evaluated through a literature review of effects from the specific contaminants identified in this study as occurring in significant concentrations in prey species.~~

The first phase of this study will focus on evaluation of contaminants in project waters. Subsequent phases, if necessary, will evaluate contamination in reservoir tributaries and the Feather River downstream from the project area. ~~Specific water bodies included in this study plan are the North, Middle, and South forks of the Feather River and the West Branch and Concow Creek just above their confluences with the reservoir, Lake Oroville, Diversion Pool, Thermalito Forebay and Afterbay, Feather River from Oroville Dam to just downstream from the Afterbay Outlet, and Oroville Wildlife Area ponds.~~

Study plans approved by the Environmental Work Group define the limits of the study area. If initial study results indicate that the study area should be expanded or contracted, the Environmental Work Group will discuss the basis for change and revise the study area as appropriate.

5.0 General Approach

Detailed Methodology and Analysis

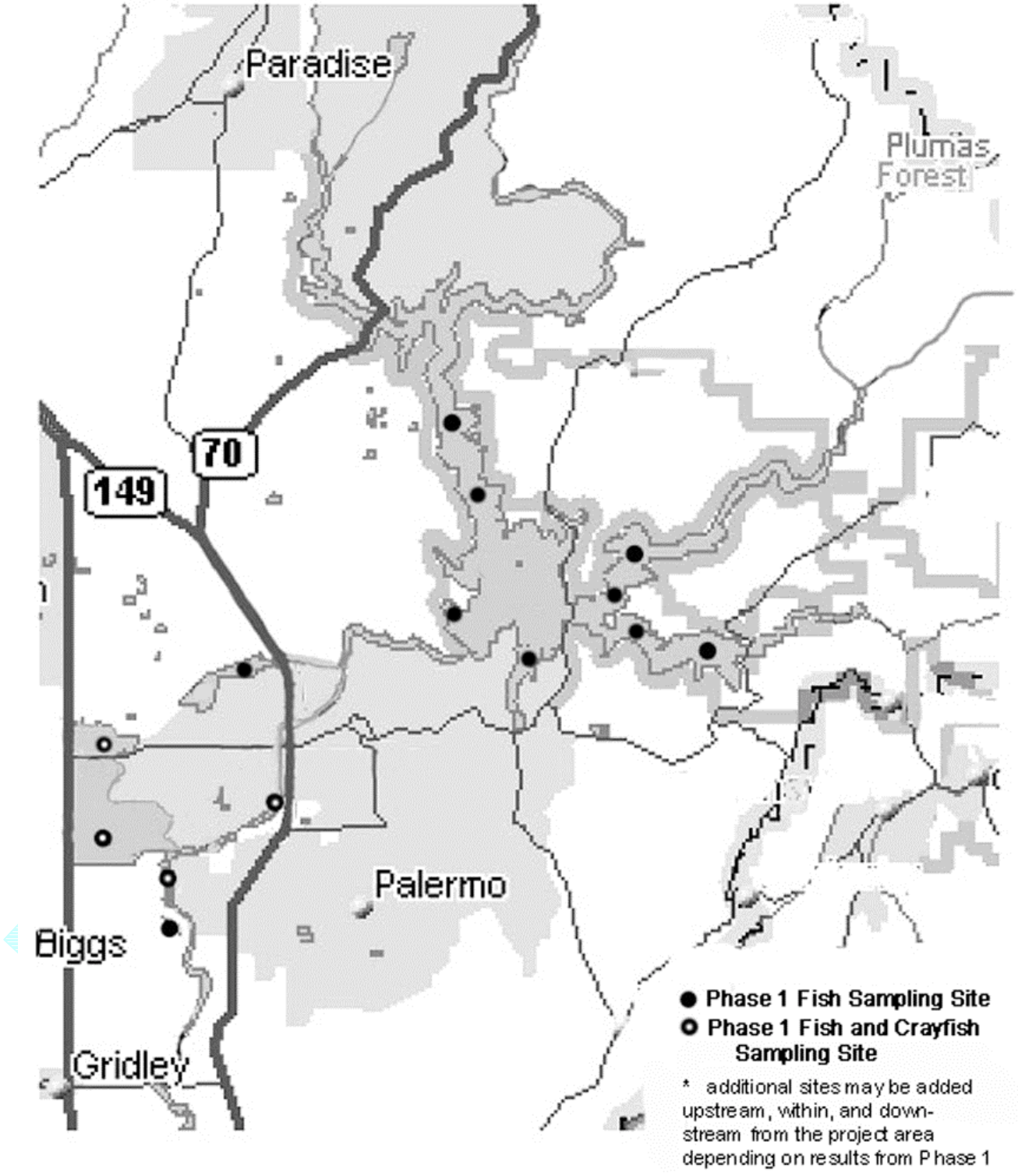
Task 1. This study will be conducted in phases. The first phase will emphasize analysis of metals and organic contaminants in fish and crayfish in the project area. If the first phase detects metals or organic contaminants at levels greater than criteria for protection of human health or fish and crayfish predators, the second phase will be initiated to further evaluate those contaminants identified in the first phase. The second phase, if necessary, ~~will~~may evaluate metals and organic contaminants in sediments and additional~~,~~ fish~~,~~ and crayfish, depending on the results of the first phase. The environmental compartments analyzed in subsequent phases will be determined in consultation with appropriate resource and health agencies and the Environmental Work Group or Task Force. Analyses in subsequent phases in tributaries to the reservoir ~~to~~would provide background data needed to evaluate the role of the reservoir in bioaccumulation. ~~The second phase would also evaluate metals and organic contaminants~~ Subsequent analyses in sediments and additional fish in the project area would provide information to determine the extent and sources of contamination, and species affected. ~~and t~~ The extent of project related impacts to fish, crayfish, and sediments downstream from the project area would also be analyzed in subsequent phases. If initial study results indicate that the methods and tasks should be modified, the Environmental Work Group will discuss the basis for change and revise the study plans as appropriate.

~~Phase 1. Project~~~~Task~~Phase 1—Project Area Metals and Organic Contaminant ~~Assessment —~~ Assessment

Water bodies sampled for ~~Phase~~~~Task~~Phase 1 of the study will include Oroville Reservoir~~, Diversion Pool~~, Thermalito Forebay and Afterbay, low flow section of the Feather River, Feather River immediately

downstream from the Afterbay Outlet, and an Oroville Wildlife Area ponds (Figure SP-W2-1). Tasks that will be undertaken in Phase 1 include sample collection, laboratory analyses, and data interpretation.

Figure SP-W2-1. Phase 1 Contaminant Monitoring Sites



Phase 1, Task 1A —Sample Collection

Phase 1 Sample Collection —Specific fish species sampled is dependent on the types resident in the water body sampled. Newly planted fish (i.e., less than one year residency) will be avoided. TwoOne larger size classes of at least two species a black bass and a catfish species will be targeted from each sampling site. Attempts will be made to collect ten large bass that are a 'keepable' size as defined in the fishing regulations (i.e., greater than 15 inches in total length), while five catfish will be collected from each site. The bass will be individually analyzed for total mercury. Subsequently, five of the bass will be composited for other analyses. fFollowing the protocol of the California Office of Environmental Health Hazard Assessment., composites of at least five fish for each size class will be collected. Each size classcomposite of bass or catfish will be composed of fish with no greater than 250 percent weight length difference in fork length between the largest and smallest fish. Attempts will be made to collect at least five bass for compositing that are a 'keepable' size, greater than 15 inches in total length. Fish will be collected beginning in the late spring with electroshockers, gill nets, hooks and lines, or seinesing. Fish will be weighed and measured, wrapped in aluminum foil, and immediately frozen for transport to the laboratory.
laboratory.

Crayfish, if present, will be collected from the same sites from which fish are collected the Thermalito Afterbay and either the low flow section or downstream from the Afterbay Outlet in the Feather River, depending on where they are found. Larger (older) crayfish will be targeted. At least ten crayfish of similar size from each site will be composited. Crayfish will be collected by hand, nets, or baited traps. Crayfish will be wrapped in aluminum foil and frozen for transport to the laboratory.

Lake Oroville —A comprehensive survey Screening forof fish and crayfish contamination in Lake Oroville requires multiple sampling sites in each arm and the main body of the reservoir. Fish and crayfish, if present, will be collected from two different sampling sites in the upper and mid reaches in each of the North, Middle, and South fork arms and from both the east (Bidwell Marina arm) and west (Spillway arm) sides of the main body of the reservoir. In addition, bass and catfish will be collected from near the Lime Saddle Marina for polynuclear aromatic hydrocarbon contamination analysis. PAH contamination of fish in other water bodies has generally not been found to be significant. The marina environment presents a worst case scenario such that if no contamination is identified near the marina, then other areas of the reservoir can reasonably be assumed to be contaminant free.

Targeted fish species will include spotted, largemouth, or smallmouth bass and channel catfish from the reservoir arms, and spotted or largemouth bass, channel catfish, and chinook or coho salmon from the main body of the reservoir.

~~Diversion Pool — The Diversion Pool will be sampled near the Diversion Dam. Fish targeted for collection from the Diversion Pool will include spotted, largemouth or smallmouth bass, and chinook or coho salmon. Crayfish will be collected from the same site.~~

- ~~—~~Thermalito Forebay, Thermalito Afterbay, and Oroville Wildlife Area — One monitoring site will be established in the northsouth Thermalito Forebay. The Thermalito Afterbay will be sampled in both the northern and southern regions. ~~Specific sampling sites in the Thermalito Afterbay will be determined in consultation with State and federal agency staff due to the complex water currents and potential for methylation of mercury in this water body~~. ~~Two~~One representative pond~~s~~ will be sampled in the Oroville Wildlife Area ~~both upstream and downstream from the Afterbay Outlet. If analyses of samples indicate significant variation in contaminant levels in these water bodies, additional samples may be necessary.~~ Warmwater fish species targeted in these water bodies will include spotted, largemouth, or smallmouth bass and channel catfish. ~~Crayfish will be collected from the same areas as the fish.~~ Crayfish will be collected from both sampling areas in the Afterbay.

- ~~—~~Lower Feather River — The Feather River downstream from Oroville Dam will be sampled at one site in the low flow section between the fish hatchery and Afterbay Outlet and at another site downstream from the outlet within the project boundary. Targeted fish species will include spotted, largemouth, or smallmouth bass and~~,~~ ~~channel~~channel catfish~~, and pikeminnow~~. Attempts will be made to sample the same species as sampled in the other project waters. Crayfish will be collected from either the low flow section or downstream from the Afterbay Outlet in the Feather River.~~riffle or pool areas~~.

Phase 1, Task 2~~1B — Sample~~Laboratory Analyse~~i~~s

~~**Phase 1 Sample Analysis** —~~Analytical procedures generally will follow those used in the Toxic Substances Monitoring Program conducted by the State Water Resources Control Board and Department of Fish and Game. Metals, pesticides, polychlorinated biphenyls, and polynuclear aromatic hydrocarbons are analyzed for this program (Table SP-W2-1). PCB congeners analyzed will be those determined to pose significant ecological risks in a U.S. Environmental Protection Agency sponsored study (USEPA 1998), rather than just those analyzed as part of the TSMP.

Table SP-W2-1. Metals and Organic Contaminants for Analyses

Analyte	Reporting Limit ppb (ng/g)	Analyte	Reporting Limit ppb (ng/g)
Organochlorine Pesticides by EPA Method 8081A			
aldrin	1	dieldrin	1
alpha-BHC	1	endosulfan I	2
beta-BHC	2	endosulfan II	2
gamma-BHC	1	endosulfan sulfate	2

Analyte	Reporting Limit ppb (ng/g)	Analyte	Reporting Limit ppb (ng/g)
delta-BHC	1	endrin	2
alpha-chlordane	1	endrin aldehyde	2
gamma-chlordane	1	endrin ketone	2
alpha-chlordene	1	heptachlor	1
gamma-chlordene	1	heptachlor epoxide	1
chlorpyrifos	2	Kelthane (dicofol)	2
chlorthal (dacthal)	2	methoxychlor	10
2,4'-DDD	2	mirex	2
2,4'-DDE	2	nonachlor, cis	2
2,4'-DDT	2	nonachlor, trans	2
4,4'-DCBP	2	oxadiazon	2
4,4'-DDD	2	oxychlordane	2
4,4'-DDE	2	tetradifon (tedion)	2
4,4'-DDT	2	toxaphene	100
4,4'-DDMU	2		
Polynuclear Aromatic Hydrocarbons by EPA Method 8270C/SIM			
acenaphthene	10	fluoranthene	10
acenaphthylene	10	fluorene	10
anthracene	10	indeno(1,2,3-cd) pyrene	10
benzo(a)anthracene	10	3-methylcholanthrene	10
benzo(b, j&k)fluoranthene	10	1-methylnaphthalene	10
benzo(g,h,i)perylene	10	2-methylnaphthalene	10
benzo(a)pyrene	10	1-methylphenanthrene	70
benzo(e)pyrene	10	naphthalene	10
biphenyl	10	perylene	10
chrysene	10	phenanthrene	10
dibenzo(a,h)anthracene	10	pyrene	10
2,6-dimethylnaphthalene	10	2,3,5-trimethylnaphthalene	10
Polychlorinated Biphenyls (PCB) Congeners by GC/ECD w/congener standards			
Congener	**Reporting Limit ppb (ng/g)**	**Congener**	**Reporting Limit ppb (ng/g)**
8	0.6	128	0.6
15	0.6	132	0.6
18	0.6	137	0.6
27	0.6	138	0.6
28	0.6	149	0.6
29	0.6	151	0.6
31	0.6	153	0.6
44	0.6	156	0.6
49	0.6	157	0.6
52	0.6	158	0.6
66	0.6	167	0.6
70	0.6	169	0.6
74	0.6	170	0.6
77	0.6	174	0.6
81	0.6	177	0.6
87	0.6	180	0.6

Analyte	Reporting Limit ppb (ng/g)	Analyte	Reporting Limit ppb (ng/g)
95	0.6	183	0.6
97	0.6	187	0.6
99	0.6	189	0.6
101	0.6	194	0.6
105	0.6	195	0.6
110	0.6	200	0.6
114	0.6	201	0.6
118	0.6	203	0.6
123	0.6	206	0.6
126	0.6	209	0.6
Organophosphorus Pesticides by EPA Method 8141A			
chlorpyrifos	2	parathion, ethyl	2
diazinon	20	parathion, methyl	4
Metals by EPA Method 6020 (ICPMS)			
arsenic*	0.02	mercury	0.01
cadmium	0.005	nickel	0.01
chromium	0.1	selenium*	0.02
copper	0.006	silver	0.005
lead	0.007	zinc	0.06
Miscellaneous Sediment Analyses			
Percent organic carbon	EPA Method 9060		
Acid volatile sulfides	EPA ABS/SEM procedures, Dec. 2, 1991		
Nonyl phenols	GC-MS/DFG		

** analysis with methanol addition*

Methylmercury is assumed to be the form of mercury available for bioaccumulation in the food web. Most mercury in fish tissues is in the methylmercury fraction. Total mercury, however, is typically analyzed from fish tissue and is assumed to represent the methylmercury content of tissues. Fish muscle (filet) tissue is analyzed for the metals arsenic, cadmium, nickel, mercury, and selenium, while fish liver is analyzed for copper, zinc, chromium, lead, and ~~zinc~~silver. All organic chemicals in fish are analyzed from filets. Whole body analyses of metals and organic chemicals are performed from very small fish and crayfish. Insufficient information is available to determine whether total mercury analyses can be used to assess the methyl mercury fraction in crayfish. Therefore, both methyl and total mercury will be analyzed from crayfish to assess mercury contamination and the relationship between methyl and total mercury. Crayfish are shelled at the laboratory prior to analysis. All fish and crayfish analyses will be performed at the Department of Fish and Game Water Pollution Control Laboratory in Rancho Cordova ~~or the West Coast Analytical Services laboratory in Santa Fe Springs, California~~.

The ten black bass obtained from each sampling site will be individually analyzed for total mercury contamination. Subsequently, five of the fish from each site will be composited following OEHHA guidelines. The black bass and catfish composites will be analyzed for organics (organochlorine and organophosphorus pesticides, and polychlorinated biphenyls) and

metals. The composites of black bass and catfish collected near the Lime Saddle marina will be analyzed for polynuclear aromatic hydrocarbons in addition to organic and metal contaminants.

The composited crayfish samples from each sampling site will be analyzed for organic contaminants and mercury.

~~Tissue concentrations of metals and organic chemicals are measured on a wet weight basis. In addition to wet weight measures, organic chemicals are also expressed on a lipid weight basis since chlorinated hydrocarbons partition into lipid-rich tissues of aquatic organisms. Season, water temperature, health of the organism, stress on the organism, and type of species can affect the lipid levels of samples, and cause variability in results. Therefore, lipid weight values may represent a more realistic measure of environmental availability of chlorinated hydrocarbons than wet weight values. Wet weight measures, however, are preferred because all standards for human health and predator protection are based on wet weight measures. Also, wet weight measures better reflect the exposure of predators or humans to the actual concentration in freshly caught fish.~~

Phase 1, Task 3~~1C – Collect and compare guidance criteria with sample results (next steps)~~Data Interpretation

Criteria and guidance values for protection of human health and wildlife from contaminant accumulation or ingestion will be researched and reviewed. Some of these criteria and guidance values include numerical criteria of the U.S. EPA and California Office of Environmental Health Hazard Assessment for human health protection, National Academy of Sciences predator protection criteria, maximum tissue residue levels and elevated data levels used by the SWRCB, action levels of the U.S. Food and Drug Administration, and median international standards for trace elements of the Food and Agriculture Organization of the United Nations. Results from Task 2 will be compared to applicable criteria and guidance values. Potential pathways for bioaccumulation in the fish will be investigated for those contaminants present at levels that pose a concern. The pathways investigation will facilitate determination of project operations that may contribute to contaminant bioaccumulation and downstream effects, and focus activities in Phase 2 of this study.

~~Phase 2. Metals~~ ~~Task~~Phase 2—Metals and Organic Contaminant Assessment ~~Pathways —~~ Pathways

If analyses in ~~Phase~~ ~~Task~~ Phase1 demonstrate ~~significant~~ contamination of fish or crayfish (i.e., criteria ~~and~~or guidelines exceeded), a second phase will be undertaken. The following Phase 2 presents a potential approach. The Environmental Work Group, based on the findings of Phase 1 and study plan SP-W1, will review~~se~~ and approve the P~~p~~hase 2 approach before implementation. It is anticipated that Phase 2 would~~will~~ evaluate sediment, fish, and crayfish contamination in the tributaries to the reservoir to determine background (i.e., upstream) ~~contributions to~~ bioaccumulation and ~~organic~~ contamination levels. Additional sport fish species would be sampled in project waters to determine the extent of species affected. Sediments and prey fish

species (such as threadfin shad or wakasagi) may also be sampled for contaminants in project water bodies. In addition, sediment, fish, and crayfish would~~would~~ be sampled downstream from the project area in the Feather River to evaluate the extent of possible project effects on downstream contamination. Parameters analyzed would include both metals and organic contaminants that were found to be significant in ~~Phase~~~~Task~~Phase 1. ~~Sediments and possibly additional fish (such as threadfin shad or wakasagi) will also be sampled for metals and organic contaminants in the project area water bodies sampled in Phase~~~~Task~~~~Phase 1 where contamination was found to be significant.~~

Phase 2, Task 1~~2A Sample Collection~~Background Assessment

Analyses in Phase 2, Task 1 will focus on tributaries to the reservoir to provide background data needed to evaluate the role of the reservoir in bioaccumulation. Data from tributaries to the reservoir will be compared to that obtained from project waters to determine whether the project had any effect in bioaccumulation above background levels present in the watershed.

~~Phase 2 Sample Collection~~ Phase 2, Task 1A—Sample Collection

- Fish and crayfish species sample collection will use the same procedures and protocols as in ~~Phase 1.~~Phase 1, Task 1. Fish and crayfish in the North, Middle, and South forks of the Feather River and the West Branch, Concow Creek, and Fall River will be sampled just above their confluences with the reservoir. Targeted fish species will include the same species sampled in Phase 1. If those species are not available, targeted species will include smallmouth bass, catfish, and pikeminnow. (However, resampling of the reservoir would then be necessary to obtain the same species for comparisons). Sediments will be collected from riffle deposits, point bars, or the bottom of pools. If deposited sediments are found to contain significant loads of contaminants, sediments in the bedload will be sampled for contaminants during the fall, winter, and spring to determine temporal variability in contamination and concentrations in sediments being transported into Lake Oroville.
- Sediments would be collected from stream deposits (point bars, riffle areas, or pools) with teflon spoons into containers provided by the laboratory. Ten samples would be collected from each site and composited into a single sample. . If deposited sediments are found to contain significant loads of contaminants, sediments in the bedload will be sampled for contaminants during the fall, winter, and spring to determine temporal variability in contamination and concentrations in sediments being transported into Lake Oroville.

Phase 2, Task 1B—Laboratory Analyses

Laboratory analyses for fish and crayfish will follow the same procedures as in Phase 1, Task 2. Sediments will be analyzed on a dry weight basis for metals, organic chemicals, percentage organic carbon, and acid volatile sulfides at the Cal-test Laboratory in Napa.

Phase 2, Task 1C—Data obtained from this Phase will be compared to criteria and guidelines to determine whether contaminant levels are present at levels that would pose a concern to human health, aquatic organisms, and the food web. Contaminant levels in fish and crayfish in the tributaries would be compared to levels in those species from project waters to determine whether the project contributed to additional bioaccumulation of contaminants in those species. The sediment data would be used to evaluate the contribution of contaminant loading from each tributary to focus future studies in the tributaries and reservoir.

Phase 2, Task 2—Project Waters Assessment

Analyses in Phase 2, Task 2 will focus on project waters to determine the extent of species affected by contamination, including additional sport fish species and prey species. Additional fish species may also need to be collected if fish species collected from the tributaries in Phase 2, Task 1 are different than those collected in Phase 1 from project waters. The same species would be targeted from project waters in this Phase as collected in the tributaries in Phase 2 so comparisons can be made to discern the role of project waters in bioaccumulation. Sediment samples would be collected from project waters to provide information on sources and loading potential.

Phase 2, Task 2A—Sample Collection

Fish species sample collection will use the same procedures and protocols as in Phase 1, Task 1. ~~Task 1.~~

~~Bottom sediments will be~~ Sediment samples from deeper project water bodies (e.g., Lake Oroville, Thermalito Afterbay) would be obtained with a core sampler during the spring to early summer prior to the development of anoxic conditions in the hypolimnion. Anoxic conditions allow some contaminants to recycle from sediments to the overlying water. The top six inches of sediments in the sampler~~dredge~~ will be collected with teflon spoons into containers provided by the laboratory. Ten core samples at each site will be composited into a single sample. Sediments would be collected in the Feather River downstream from the dam within the project area from deposits (point bars, riffle areas, or pools) with teflon spoons into containers provided by the laboratory. Ten samples would be collected from each site and composited into a single sample.

- ~~Feather River Tributaries — Fish, crayfish, and sediments in the North, Middle, and South forks of the Feather River and the West Branch, Concow Creek, and Fall River will be sampled just above their confluences with the reservoir. Targeted fish species will include rainbow trout, smallmouth bass, and pikeminnow. Sediments will be collected from riffle deposits, point bars, or the bottom of pools. If deposited sediments are found to contain significant loads of metals or organic contaminants, sediments in the bedload will be sampled for contaminants during the fall, winter, and spring to determine temporal variability in contamination and concentrations in sediments being transported into Lake Oroville.~~

———Lake Oroville — Fish and sSediments will be collected as much as possible from the same sites from which fish and crayfish were sampled in PhasePhaseTask 1. Additional sport fish targeted for sampling include brown trout, chinook or silver salmon, bass, and sunfish. Additional sites for sediment samples may be necessary in the main body of the reservoir due to the areal extent and potential for different loading from each arm of the reservoir. The need to collect additional samples will be determined by the variability found in the initial samples.

———Prey fish species (threadfin shad and wakgasagki) in the reservoir may be sampled if high contaminant loads are found in fish that prey on them in PhasePhaseTask 1. If necessary, these species will be collected with gill nets or seines.

- ——Diversion Pool — Fish and sSediments will be collected from the Diversion Pool at the same site selected for fish and crayfish sampling in PhasePhaseTask 1.near the Diversion Dam. Sport fish targeted for sampling include rainbow and brown trout, catfish, bass, and sunfish.

- ——Thermalito Forebay, Thermalito Afterbay, and Oroville Wildlife Area — Sediments will be sampled in these water bodies in the same areas from which fish and crayfish were sampled in Phase 1. Sport fish targeted for sampling include rainbow and brown trout, catfish, bass, and sunfish.

———Lower Feather River — Sediments will be collected from riffle deposits or from the bottom of pools in the previously sampled sites in the low flow section of the river and downstream from the Afterbay Outlet in the project area. Fish targeted for sampling will include bass, catfish, and sunfish.. Additional sites may be necessary to sample downstream from the Afterbay Outlet as far downstream as the mouth of the Feather River if significant contamination is found in fish, crayfish, or sediments to determine the extent of effect to contamination from the project. The necessity for sampling downstream from the project area will be determined after results from PhasePhaseTask 1 are reviewed in consultation with State and federal agency staffs.

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- (PLACEHOLDER) The vulnerability of piscivorous wildlife species to bioaccumulated contaminants will be evaluated in the terrestrial studies if fish eaten as prey are found to contain high levels of contaminants. The assessment of piscivorous susceptibility will be evaluated through a literature review of effects from the specific contaminants identified in this study as occurring in significant concentrations in prey species.

Phase 2, Task 2B—LaboratorySample Analyseis

Phase 2 Sample Analysis — Analytes,Analyses, laboratories, and procedures for fish and sedimentcrayfish analyses will be the same as in the previous Phases. PhaseTask 1 Sediments will be analyzed on a dry weight basis for metals, organic chemicals, percentage organic carbon, and acid volatile sulfides at the Cal-test Laboratory in Napa.

Phase 2, Task 2C—Data Interpretation

Data obtained from this Task will be compared to criteria and guidance values to determine the extent of contamination of fish species and need for advisories or additional information. The data will also be evaluated to identify potential pathways for bioaccumulation, including contaminant loading, deposition, and cycling.

Phase 2, Task 3.

This Phase of the study would determine the extent of project related impacts to fish, crayfish, and sediments downstream from the project area. Parameters analyzed would include both metals and organic contaminants that were found to be significant in Phase 1.

Phase 2, Task 3A—Sample Collection

Fish, crayfish, and sediment sample collection will use the same procedures and protocols as in previous Phases which are appropriate for stream sampling. Methods used will avoid species of concern. Targeted species include bass, catfish, and sunfish.

Phase 2, Task 3B— Laboratory Analyses

Analyses, laboratories, and procedures for fish and sediment analyses will be the same as in the previous Phases.

Phase 2, Task 3C—Data Interpretation

Data from this Phase will be evaluated to determine the extent of project related impacts to fish, crayfish, and sediments downstream from the project area. The data will be compared to criteria and guidance values researched in Phase 1.

Task 2. Progress Reports—Interim output products will be identified through coordination with other work groups to meet their data needs. Progress reports will be prepared at the conclusion of each Phase of the study.

Task 3. Final Report—A final report will be prepared following completion of the study.

6.0 Results and Products/Deliverables

Results

~~———~~Information from this study will be used to evaluate the effects of the project and project operations on contamination in sediments and bioaccumulation of contaminants in fish and crayfish. Information developed will be presented quarterly to the Environmental Work group and Task Force for review to evaluate the adequacy and progress of the study.

~~———~~Data obtained from this study will be compared to criteria and guidelines established for the protection of human health, fish, and wildlife species.~~to numerical criteria of the U.S. EPA and California Office of~~

~~Environmental Health Hazard Assessment for human health concern, and National Academy of Sciences predator protection criteria. Additional criteria used for evaluation of the data will include maximum tissue residue levels developed by the SWRCB, action levels of the U.S. Food and Drug Administration, median international standards for trace elements of the Food and Agriculture Organization of the United Nations, and elevated data levels of the SWRCB.~~ Data will be presented in tables and graphs showing the relationship between concentrations of any contaminants found and the various criteria and guidance values.

Compliance with criteria guidance values will be used to evaluate compliance with Basin Plan objectives, which is necessary for the SWRCB to issue a water quality certification. The water quality certification must be submitted to the Federal Energy Regulatory Commission with the application for a new license for the project.

A draft report documenting findings will be prepared after completion of ~~Phase~~Phase~~Task~~ 1, and a final report with results and recommendations will be prepared at the completion of ~~Phase~~Phase~~Task 2~~subsequent Phases, if necessary. The draft report following completion of Phase 1 will include information about potential risks to wildlife from ingestion of contaminated fish species for evaluation in the terrestrial studies.

~~(insert language discussing an interim report to terrestrial group regarding terrestrial contaminant movement up food chain from consumption of prey fish species)~~

7.0 Coordination and Implementation Strategy

Coordination with Other Resource Areas/Studies

This study will provide information for evaluation of Issue Sheet W6 (effect of existing and future project facilities and operations on sediment deposition and potential impoundment of metals and toxins, including the potential presence and uptake of methylmercury through the food chain) and will be coordinated with Study Plan SPG1 (Geology Issue G4 - project effect on sediment accumulation upstream of the dam). Information derived from SPG1 will be used to determine the magnitude of potentially contaminated sediment influx into the reservoir.

Issues~~, Concerns, Comments Tracking, and/or Regulatory Compliance Requirements~~

This study plan provides the information for evaluation of Issue Statement **W6 (effect of existing and future project facilities and operations on sediment deposition and potential impoundment of metals and toxins, including the potential presence and uptake of methylmercury through the food chain. Lake Oroville, fed by tributaries that have a history of gold mining activity, has potential for accumulation of elemental mercury in its basin sediments). This study directly or indirectly addresses the following specific issues:**

~~W6 Effect of existing and future project facilities and operations on sediment deposition and potential impoundment of metals and toxins, including the potential presence and uptake of methylmercury through the food chain.~~

~~Lake Oroville, fed by tributaries that have a history of gold mining activity, has potential for accumulation of elemental mercury in its basin sediments. The following Issues will also be addressed: WE7, WE13, WE41, G4, and F6.~~

Direct

- WE 7. Lake Oroville, fed by tributaries that have a history of gold mining activity, has potential for accumulation of elemental mercury in its basin sediments. Potential presence and uptake of methylmercury through the food chain must be assessed
- F6. Effects of existing and future project operations on sediment deposition, erosion, and recruitment through the system (including downstream sediment supply) and associated changes in water quality on the quantity and quality of aquatic habitats within project affected waters.

Indirect

- WE 13. Reduce sediment yields from watersheds in deteriorating conditions and those tributary to eroding channels or hazardous flood prone areas
- WE 41. What coordination for Page 2 #5? -- Could be items along roads that might sweep into the river during floods.
- G4. Project effects on sediment accumulation upstream of the dam.

(Expanded Issues Addressed: GE19, GE22, W6, W9)

8.0 Study Schedule

The study will begin in the spring of 2002. Collection of samples necessary for analyses of the significance of metals and organic contamination in fish and crayfish in project waters ~~(Phase~~(Phase~~Task~~ 1) should be completed by early summer of 2002. If necessary, additional samples to determine effects from tributary contributions, sediment loads, and downstream effects would occur later in 2002 or the following year. Additional samples may be necessary in subsequent years if sampling attempts fail to collect the requisite samples or if particularly contaminated samples are encountered. A draft report discussing sampling, analytical results, project implications, and recommendations will be completed at the end of each phase of the study~~study year~~.

~~**Issues**~~

~~W6. Effect of existing and future project facilities and operations on sediment deposition and potential impoundment of metals and toxins, including the potential presence and uptake of methylmercury through the food chain. Lake Oroville, fed by tributaries that have a history of gold mining activity, has potential for accumulation of elemental mercury in its basin sediments. Issues Addressed: WE7, WE13, WE41, G4, F6~~